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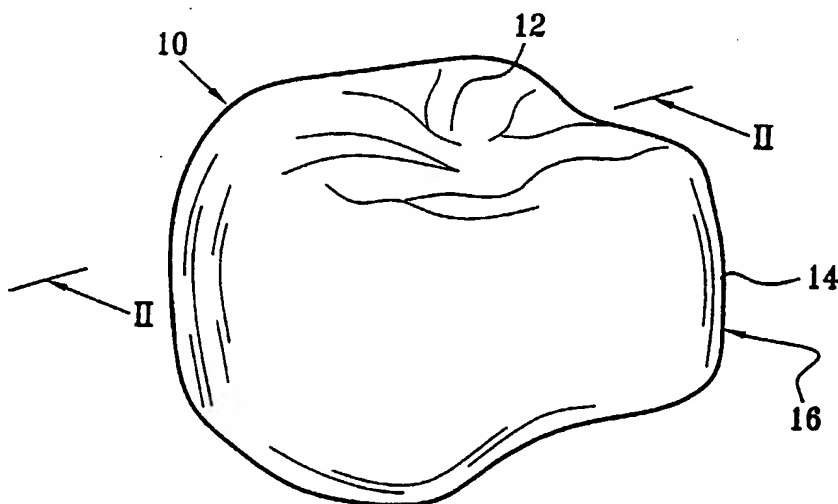
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European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR,  
GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent  
(BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR,  
NE, SN, TD, TG).

**Published:**

— without international search report and to be republished  
upon receipt of that report

For two-letter codes and other abbreviations, refer to the "Guid-  
ance Notes on Codes and Abbreviations" appearing at the begin-  
ning of each regular issue of the PCT Gazette.

(54) Title: ACETAL RESIN CROWNS FOR CHILDREN



(57) Abstract: An injection molded dental crown formed of an acetal homopolymer resin. A method for mass producing dental crowns is also disclosed.



WO 02/083022 A2

## ACETAL RESIN CROWNS FOR CHILDREN FIELD OF THE INVENTION

The present invention relates to tooth prostheses generally and more particularly to crowns.

## BACKGROUND OF THE INVENTION

The following U.S. Patents and publications are believed to represent the current state of the art: 4,129,946; 5,552,390; 5,487,663; 5,624,261; 5,709,548; 6,106,295;

## SUMMARY OF THE INVENTION

The present invention seeks to provide a mass-produced, tooth colored pre-fabricated crown, particularly useful in pediatric dentistry for treatment of primary teeth and permanent molars having extensive carious lesions.

There is thus provided in accordance with a preferred embodiment of the present invention an injection molded dental crown formed of an acetal homopolymer, which includes Polioxymethylene (POM) Thermoplastic Homopolymer.

In accordance with a preferred embodiment of the present invention, the injection molded dental crown is formed with depending side surfaces at least one of which defines an undercut.

Preferably, the depending side surfaces are flexible.

There is also provided in accordance with a preferred embodiment of the present invention a method for mass producing dental crowns comprising: providing a multi-element mold, employing the multi-element mold to injection mold the crown including depending side surfaces, at least one of which defines an undercut.

In accordance with a preferred embodiment of the present invention, the multi-element mode includes an ejector which is operative to eject the molded crown following opening of the multi-element mold.

## BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated more fully from the following detailed description, taken in conjunction with the drawings in which:

Fig. 1 is a simplified pictorial illustration of a dental crown formed of

acetal homopolymer;

Fig. 2 is a sectional illustration of the dental crown of Fig. 1, taken along lines II - II in Fig. 1; and

Figs. 3A, 3B and 3C are each simplified pictorial illustrations of apparatus for manufacturing a dental crown from acetal homopolymer resin in accordance with a preferred embodiment of the present invention in three operative orientations.

#### DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Reference is now made to Fig. 1, which is a simplified pictorial illustration of a dental crown formed of acetal homopolymer resin and to Fig. 2, which is a sectional illustration of the dental crown of Fig. 1, taken along lines II - II in Fig. 1.

As seen in Figs. 1 and 2, there is provided in accordance with a preferred embodiment of the present invention an injection molded dental crown 10 formed of an acetal homopolymer resin. A preferred material for the crown is acetal homopolymer resin (DELRIN®) which is commercially available from DuPont.

As can be readily seen in Figs. 1 and 2, the dental crown 10 is formed with a generally conventionally tooth shaped top surface 12 and depending side surfaces 14 at least one of which defines an undercut 16. Preferably, the depending side surfaces 14 are flexible. Crown 10 may readily be mounted, by conventional methods, such as through the use of dental cement in the mouth of a patient, typically a child, as part of treatment of primary teeth and permanent molars having extensive carious lesions. It is a particular feature of the invention that crown 10 is of a color which generally matches of the patient's teeth.

The crown of the present invention is characterized by high tensile strength, high impact resistance and stiffness, excellent fatigue endurance and resistance to moisture, excellent dimensional stability and sufficient resilience and resistance to creep. It has the natural appearance of a vital tooth

Reference is now made to Figs. 3A, 3B and 3C, which are each simplified pictorial illustrations of apparatus for manufacturing a dental crown from acetal homopolymer resin in accordance with a preferred embodiment of the present invention in three operative orientations.

As seen in Figs. 3A, 3B and 3C, the crown 10 is molded in a mold cavity 20 which is defined by a top mold element 22, a bottom mold element 24 and an ejector

26. The ejector 26 forms part of an internal mold element 32.

Fig. 3A shows the stage of molding when the top mold element 22 lies in tight engagement with the bottom mold element 24 and the ejector 26. The dental crown 10, which is fabricated on the ejector 26, is formed by the injection of acetal homopolymer resin material from a source of acetal homopolymer resin (not shown) into the mold cavity 20, via a channel 30 cut in the top mold element 22.

Fig. 3B shows an initial release stage wherein the bottom mold element 24 is separated from the top mold element 22, thus permitting removal of the molded crown 10 from cavity 20.

Fig. 3C shows an ejection stage wherein ejector 26, driven by a piston 28 moves upwardly relative to bottom mold element 24 and pushes crown 10 out of cavity 20. Due to the resilience of the depending side surfaces 14, the action of the ejector 26 is able to disengage the internal mold element 32 from the crown 10 notwithstanding the presence of undercut 16:

It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. Rather the scope of the present invention includes both combinations and subcombinations of the various features described hereinabove as well as variations and modifications which would occur to persons skilled in the art upon reading the specification and which are not in the prior art.

## CLAIMS

1. An injection molded dental crown formed of an acetal homopolymer resin.
2. An injection molded dental crown according to claim 1 and being formed with depending side surfaces.
3. An injection molded dental crown according to claim 2 and wherein at least one of said depending side surfaces defines an undercut.
4. An injection molded dental crown according to claim 2 and wherein said depending side surfaces are flexible.
5. An injection molded dental crown according to claim 3 and wherein said depending side surfaces are flexible.
6. A method for mass producing dental crowns comprising:  
providing a multi-element mold; and  
employing the multi-element mold to injection mold a dental crown from an acetal homopolymer resin.
7. A method according to claim 6 and wherein said multi-element mode includes an ejector, said method also comprising operating said ejector to eject the molded crown following opening of the multi-element mold.
8. A method according to claim 6 and wherein said employing step includes forming said dental crown with depending side surfaces.
9. A method according to claim 7 and wherein said employing step includes forming said dental crown with depending side surfaces.
10. A method according to claim 8 and wherein at least one of said depending side surfaces defines an undercut.
11. A method according to claim 9 and wherein at least one of said

depending side surfaces defines an undercut.

12. A method according to claim 8 and wherein said depending side surfaces are flexible.

13. A method according to claim 9 and wherein said depending side surfaces are flexible.

FIG. 1

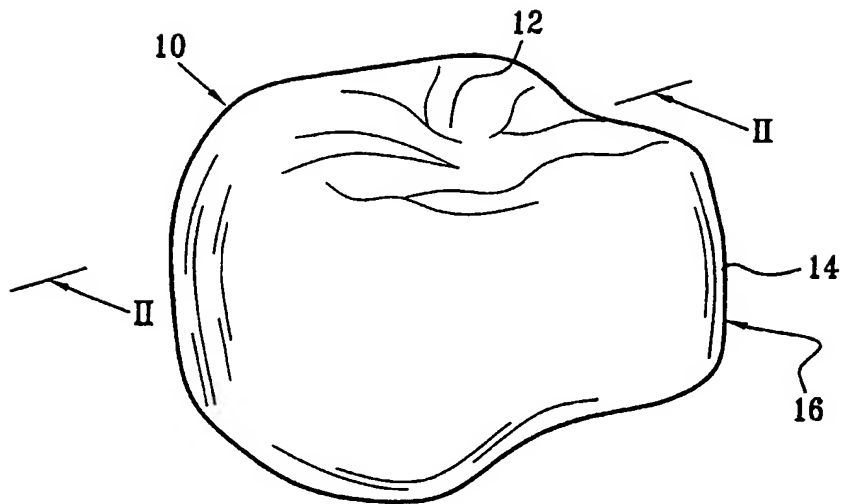
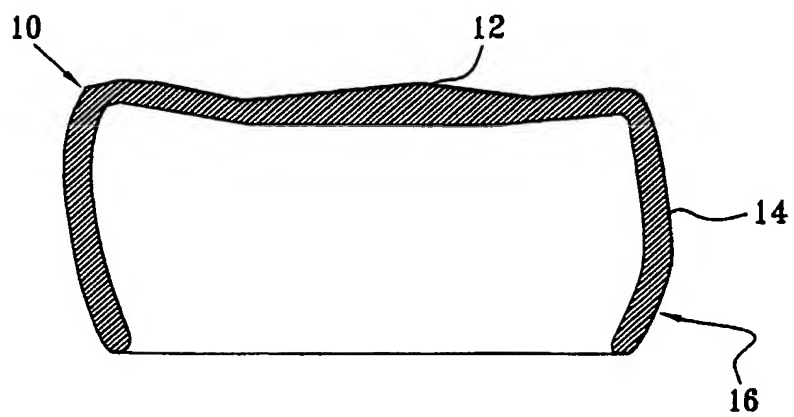
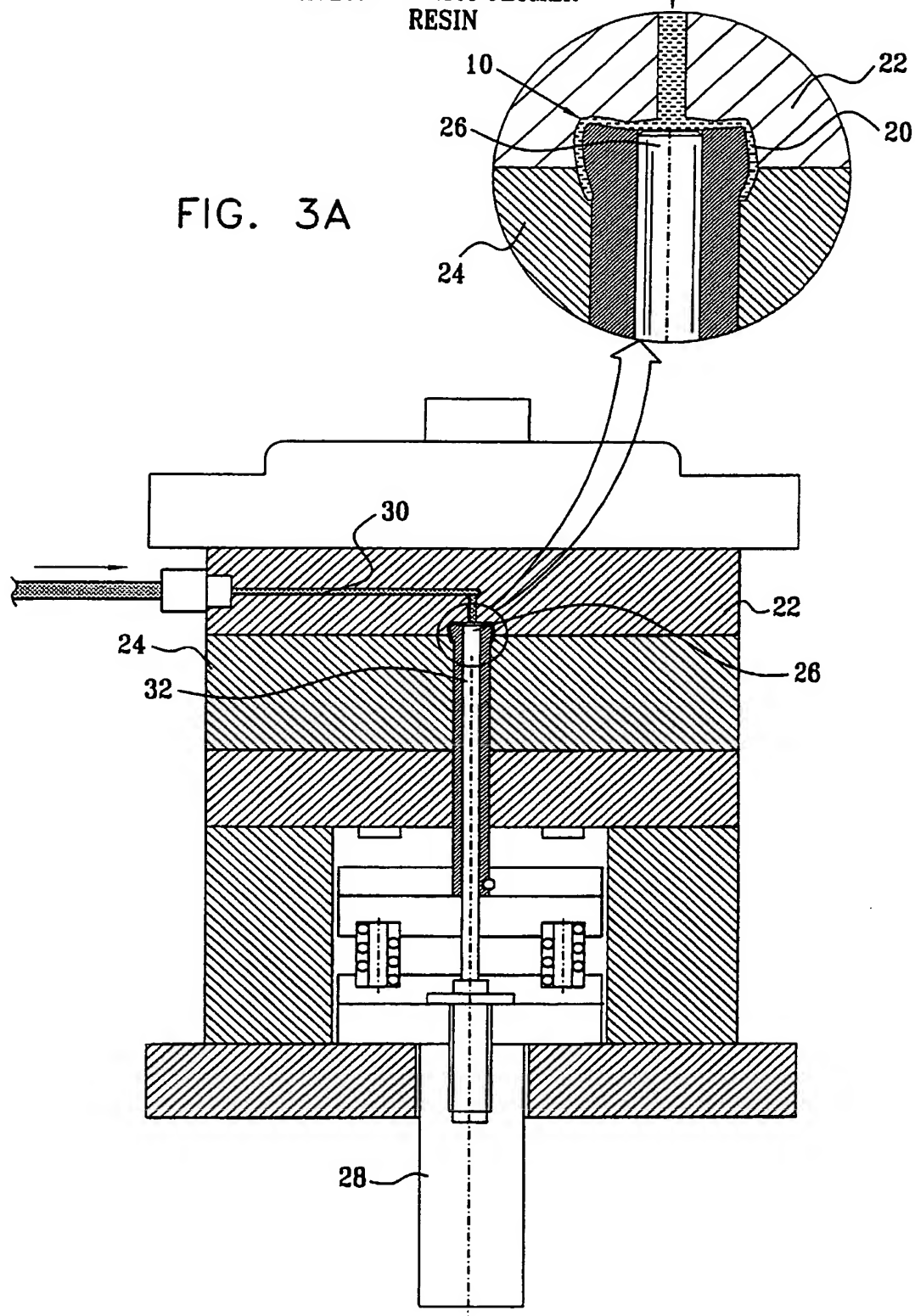


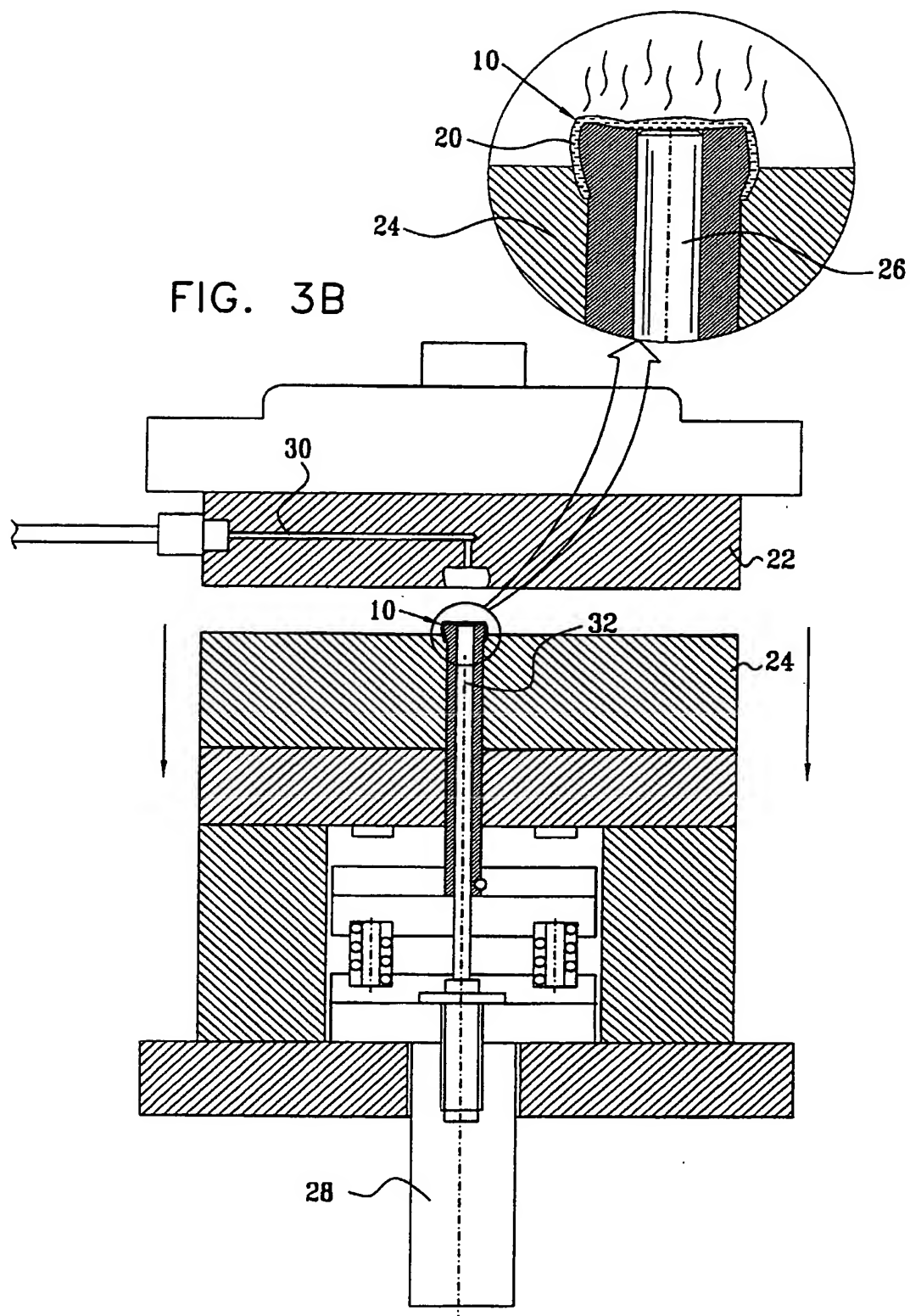
FIG. 2

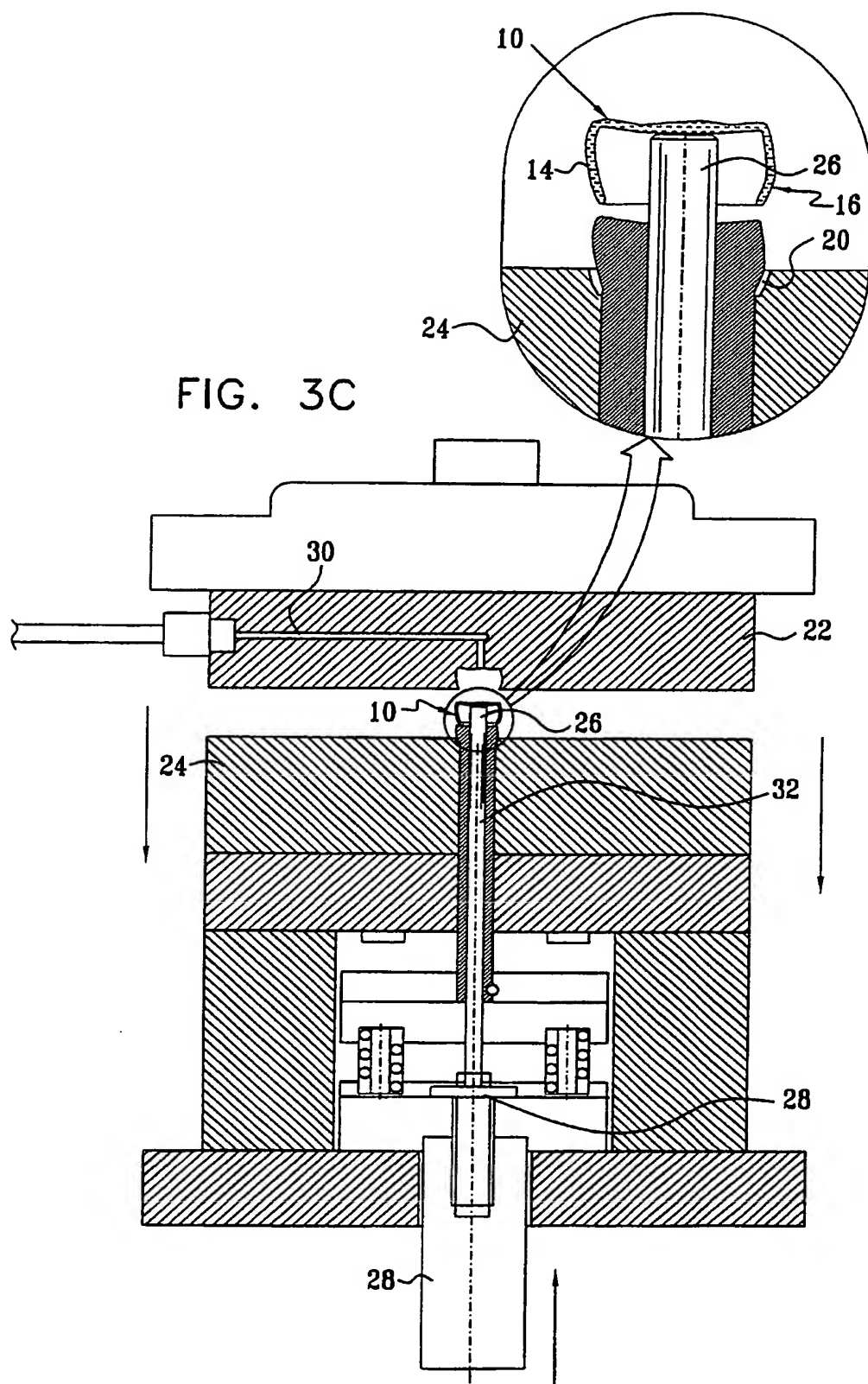


FROM SOURCE OF  
ACETAL HOMOPOLYMER  
RESIN









# PATENT COOPERATION TREATY

4ry 4558  
281

From the INTERNATIONAL SEARCHING AUTHORITY

To:  
SANFORD T. COLB  
SANFORD T. COLB & CO.  
P.O. BOX 2273  
REHOVOT, ISRAEL 76122

## PCT

### NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT OR THE DECLARATION

(PCT Rule 44.1)

Applicant's or agent's file reference 45588	Date of Mailing (day/month/year) <b>04 APR 2003</b>
International application No. PCT/IL02/00310	International filing date (day/month/year) 16 April 2002 (16.04.2002)
Applicant ZILBERMAN, URI L.	

1. ☒ The applicant is hereby notified that the international search report has been established and is transmitted herewith.

**Filing of amendments and statement under Article 19:**  
The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

Where? Directly to the International Bureau of WIPO, 34, chemin des Colombettes  
1211 Geneva 20, Switzerland, Facsimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

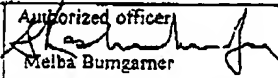
4. **Reminders**

Shortly after 18 months from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90 bis.1 and 90 bis.3, respectively, before the completion of the technical preparations for international publication.

Within 19 months from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later); otherwise the applicant must, within 20 months from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

In respect of other designated Offices, the time limit of 30 months (or later) will apply even if no demand is filed within 19 months.

See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the ISA/US Commissioner for Patents Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer  Melba Bumgarner Telephone No. 703-308-0858
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Form PCT/ISA/220 (April 2002) (See notes on accompanying sheet)

202 P.02 0371209407

TO

FROM ATI RSHKELON 11:21 14-OCT-2003

# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 45588	<b>FOR FURTHER ACTION</b>	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/IL02/00310	International filing date (day/month/year) 16 April 2002 (16.04.2002)	(Earliest) Priority Date (day/month/year) 17 April 2001 (17.04.2001)
Applicant ZILBERMAN, URI L.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.



It is also accompanied by a copy of each prior art document cited in this report.

#### 1. Basis of the Report

a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.



the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing:



contained in the international application in written form.



filed together with the international application in computer readable form.



furnished subsequently to this Authority in written form.



furnished subsequently to this Authority in computer readable form.



the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.



the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☐ Unity of invention is lacking (See Box II).

4. With regard to the title,



the text is approved as submitted by the applicant.



the text has been established by this Authority to read as follows:

5. With regard to the abstract,



the text is approved as submitted by the applicant.



the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No. 1



as suggested by the applicant.



because the applicant failed to suggest a figure.



because this figure better characterizes the invention.



None of the figures

Form PCT/ISA/210 (first sheet) (July 1998)

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL02/00310

## Box III TEXT OF THE ABSTRACT (Continuation of Item 5 of the first sheet)

The technical features mentioned in the abstract do not include a reference sign between parentheses (PCT Rule 8.1(d)).

### NEW ABSTRACT

An injection molded dental crown (10) formed of an acetal homopolymer resin and a method for mass producing dental crowns.

Form PCT/ISA/210 (continuation of first sheet(2)) (July 1998)

037109407 P.05

TO

14-OCT-2003 11:23 FROM ATI ASHKELON

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/II.02/00310

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A61C 5/08

US CL : 433/218

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
U.S. : 433/218, 219, 222.1, 223, 202.1, 212.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,186,790 B1 (KARMAKER et al) 13 February 2001, column 1-3.	1
—		—
Y		6
X	US 5,346,397 A (BRAJMAN) 13 September 1994, column 1-3, figure 3.	1-3
—		—
Y		8-13
Y	US 5,672,305 A (KOGURE) 30 September 1997, columns 1-7.	6-13
Y	US 5,730,926 A (MATSUMOTO et al) 24 March 1998, columns 1-5.	7

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T"

"X"

"Y"

"&"

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

document number of the same patent family

Date of the actual completion of the international search

30 August 2002 (30.08.2002)

Date of mailing of the international search report

04 APR 2003

Name and mailing address of the ISA/US

Commissioner of Patents and Trademarks

Box PCT

Washington, D.C. 20231

Facsimile No. (703)305-3230

Authorized officer

Melba Bumgarner

Telephone No. 703-308-0858

Form PCT/ISA/210 (second sheet) (July 1998)

## PATENT COOPERATION TREATY

RMD

From the  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITYTo:  
PETER S. LUDWIG  
DARBY & DARBY  
805 THIRD AVENUE  
27TH FLOOR  
NEW YORK, NY 10022-7513

PCT

DUE: July 27 2003 WRITTEN OPINION  
Docketed on 6/6 by DA for (PCT Rule 66)  
Docketed without file ☐Date of Mailing 27 MAY 2003  
(day/month/year)

Attorney

Applicant's or agent's file reference

REPLY DUE

within 2 months/days from  
the above date of mailing

6727/2M255-WO

International application No.

International filing date (day/month/year)

Priority date (day/month/year)

PCT/IL02/00310

16 April 2002 (16.04.2002)

17 April 2001 (17.04.2001)

International Patent Classification (IPC) or both national classification and IPC

IPC(7): A61C 5/08 and US Cl.: 433/218.

Applicant

ZILBERMAN, URI

1. This written opinion is the first (first, etc.) drawn by this International Preliminary Examining Authority.
2. This opinion contains indications relating to the following items:
  - I ☒ Basis of the opinion
  - II ☐ Priority
  - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
  - IV ☐ Lack of unity of invention
  - V ☒ Reasoned statement under Rule 66.2 (a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
  - VI ☐ Certain documents cited
  - VII ☐ Certain defects in the international application
  - VIII ☐ Certain observations on the international application
3. The applicant is hereby invited to reply to this opinion.
 

When? See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension. See Rule 66.2(d).

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also For an additional opportunity to submit amendments, see Rule 66.4.  
For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 bis.  
For an informal communication with the examiner, see Rule 66.6

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.
4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 16 August 2004 (16.08.2004)

Name and mailing address of the IPEA/US

Mail Stop PCT, A/E IPEA/US

Commissioner for Patents

P.O. Box 1450

Alexandria, Virginia 22313-1450

Facsimile No. (703)305-3230

Form PCT/IPEA/408 (cover sheet) (July 1998)

Authorized official

Melba Bumgarner

Telephone No. 703-308-0858

## WRITTEN OPINION

International application No.

PCT/IL02/00310

## 1. Basis of the opinion

## 1. With regard to the elements of the international application:\*

- ☒ the international application as originally filed:
- ☒ the description:  
 pages 1-3, as originally filed  
 pages NONE, filed with the demand  
 pages NONE, filed with the letter of \_\_\_\_\_
- ☒ the claims:  
 pages 4 and 5, as originally filed  
 pages NONE, as amended (together with any statement) under Article 19  
 pages NONE, filed with the demand  
 pages NONE, filed with the letter of \_\_\_\_\_
- ☒ the drawings:  
 pages 1-4, as originally filed  
 pages NONE, filed with the demand  
 pages NONE, filed with the letter of \_\_\_\_\_
- ☐ the sequence listing part of the description:  
 pages NONE, as originally filed  
 pages NONE, filed with the demand  
 pages NONE, filed with the letter of \_\_\_\_\_

## 2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language \_\_\_\_\_ which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

## 3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the written opinion was drawn on the basis of the sequence listing:

- ☐ contained in the international application in printed form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages NONE
- ☐ the claims, Nos. NONE
- ☐ the drawings, sheets/figs NONE

5. ☐ This opinion has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed."



## WRITTEN OPINION

International application No.  
PCT/IL02/00310

## V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

## 1. STATEMENT

Novelty (N)	Claims 4-13	YES
	Claims 1-3	NO
Inventive Step (IS)	Claims 4, 5, 12 and 13	YES
	Claims 1-3 and 6-11	NO
Industrial Applicability (IA)	Claims 1-13	YES
	Claims NONE	NO

## 2. CITATIONS AND EXPLANATIONS

Claim 1 lacks novelty under PCT Article 33(2) as being anticipated by KARMAKER et al. Karmaker et al. disclose an injection molded dental crown formed of an acetal homopolymer resin (col. 2 line 1).

Claims 1-3 lack novelty under PCT Article 33(2) as being anticipated by BRAIMAN. Braiman discloses a dental crown formed of an acetal homopolymer resin (col. 1 line 40). As to claims 2 and 3, Braiman shows depending side surfaces and at least one of the surfaces showing an undercut (a cut made to the under part to remove material) as seen in figure 3.

Claim 6 lack an inventive step under PCT Article 33(3) as being obvious over KOGURE in view of KARMAKER et al. Kogure discloses a method for mass producing dental prosthesis comprising providing a multi-element mold and employing the mold to injection mold prostheses from resin; however, Kogure does not show resin of acetal homopolymer. Karmaker et al. teach employing acetal homopolymer resin. It would have been obvious to one of ordinary skill in the art to employ the material Karmaker in the method to have a material that is easily injection molded and cured into shapes of mold contours.

Claim 7 lacks an inventive step under PCT Article 33(3) as being obvious over the prior art as applied in the immediately preceding paragraph and further in view of MATSUMOTO et al. The modified method of Kogure and Karmaker et al. shows the limitations as described above; however, they do not show the mold including an ejector. Matsumoto et al. teach a method providing a multi-element mold including an ejector. It would have been obvious to further modify the method to include an ejector to aid in removing the resin article from the mold.

Claims 8-11 lack an inventive step under PCT Article 33(3) as being obvious over the prior art as applied in the preceding paragraph and further in view of BRAIMAN. The modified method of Kogure and Karmaker et al. shows the limitations as described above; however, they do not show forming the dental crown with depending side surfaces. It would have been obvious to further modify the method to include the surfaces of Braiman to attach the crown to the prosthesis support in the patient's mouth as taught by Braiman.

Claims 4, 5, 12 and 13 meet the criteria set out in PCT Article 33(2)-(3), because the prior art does not teach or fairly suggest injection molded dental crown formed of an acetal homopolymer resin having depending side surfaces that are flexible.

Claims 1-13 meet the criteria set out in PCT Article 33(4), and thus meet industrial applicability because the subject matter claimed can be made or used in industry.

## NEW CITATIONS

NONE

## WRITTEN OPINION

International application No.  
PCT/IL02/00310Supplemental Box  
(To be used when the space in any of the preceding boxes is not sufficient)

## TIME LIMIT:

The time limit set for response to a Written Opinion may not be extended. 37 CFR 1.484(d). Any response received after the expiration of the time limit set in the Written Opinion will not be considered in preparing the International Preliminary Examination Report.